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L1: Entry 4 of 6 File: USPT Feb 9, 1999

US-PAT-NO: 5868123
DOCUMENT-IDENTIFIER: US 5868123 A

TITLE: Magnetic core-coil assembly for spark ignition systems

DATE-ISSUED: February 9, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
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ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
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APPL-NO: 8/ 672909
DATE FILED: June 28, 1996

INT-CL: [6] F02D 3/02

US-CL-ISSUED: 123/634
US-CL-CURRENT: 123/634

FIELD-OF-SEARCH: 123/634, 123/635

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

Search Selected Search ALL

	PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL
☐	4502454	March 1985	Hamai et al.	123/634 X
☐	5377652	January 1995	Noble et al.	123/634
☐	5456241	October 1995	Ward	123/637 X

09/779,877

ART-UNIT: 342

PRIMARY-EXAMINER: Argenbright; Tony M.

ATTY-AGENT-FIRM: Buff; Ernest D.

ABSTRACT:

A magnetic core-coil assembly generates an ignition event in a spark ignition

internal combustion system having at least one combustion chamber. The assembly comprises a magnetic core of amorphous metal having a primary coil for low voltage excitation and a secondary coil for a high voltage output to be fed to a spark plug. A high voltage is generated in the secondary coil within a short period of time following excitation thereof. The assembly senses spark ignition conditions in the combustion chamber to control the ignition event.

7 Claims, 5 Drawing figures
Exemplary Claim Number: 1
Number of Drawing Sheets: 4

BRIEF SUMMARY:

BACKGROUND OF THE INVENTION

Cross Reference to Related Applications

This application claims the benefit of U.S. Provisional Application No. 60/004,815, filed Oct. 5, 1995.

1. Field of the Invention

This invention relates to spark ignition systems for internal combustion engines; and more particularly to a spark ignition system which improves performance of the engine system and reduces the size of the magnetic components in the spark ignition transformer.

2. Description of the Prior Art

In a spark-ignition internal combustion engine, a flyback transformer is commonly used to generate the high voltage needed to create an arc across the gap of the spark plug igniting the fuel and air mixture. The timing of this ignition spark event is critical for best fuel economy and low exhaust emission of environmentally hazardous gases. A spark event which is too late leads to loss of engine power and loss of efficiency. A spark event which is too early leads to detonation, often called "ping" or "knock", which can, in turn, lead to detrimental pre-ignition and subsequent engine damage. Correct spark timing is dependent on engine speed and load. Each cylinder of an engine often requires different timing for optimum performance. Different spark timing for each cylinder can be obtained by providing a spark ignition transformer for each spark plug.

To improve engine efficiency and alleviate some of the problems associated with inappropriate ignition spark timing, some engines have been equipped with microprocessor-controlled systems which include sensors for engine speed, intake air temperature and pressure, engine temperature, exhaust gas oxygen content, and sensors to detect "ping" or "knock". A knock sensor is essentially an electro-mechanical transducer whose sensitivity is not sufficient to detect knock over the whole range of engine speed and load. The microprocessor's determination of proper ignition spark timing does not always provide optimum engine performance. A better sensing of "knock" is needed.

A disproportionately greater amount of exhaust emission of hazardous gases is created during the initial operation of a cold engine and during idle and off-idle operation. Studies have shown that rapid multi-sparking of the spark plug for each ignition event during these two regimes of engine operation reduces hazardous exhaust emissions. Accordingly, it is desirable to have a spark ignition transformer which can be charged and discharged very rapidly.

A coil-per-spark plug (CPP) ignition arrangement in which the spark ignition transformer is mounted directly to the spark plug terminal, eliminating a high voltage wire, is gaining acceptance as a method for improving the spark ignition timing of internal combustion engines. One example of a CPP ignition arrangement is that disclosed by U.S. Pat. No. 4,846,129 dated Jul. 11, 1989 (hereinafter "the Noble patent"). The physical diameter of the spark ignition transformer must fit into the same engine tube in which the spark plug is mounted. To achieve the engine diagnostic goals envisioned in the Noble patent, the patentee discloses an indirect method utilizing a ferrite core. Ideally the magnetic performance of the spark ignition transformer is sufficient throughout the engine operation to sense

the sparking condition in the combustion chamber. Clearly, a new type of ignition transformer is needed for accurate engine diagnosis.

Engine misfiring increases hazardous exhaust emissions. Numerous cold starts without adequate heat in the spark plug insulator in the combustion chamber can lead to misfires, due to deposition of soot on the insulator. The electrically conductive soot reduces the voltage increase available for a spark event. A spark ignition transformer which provides an extremely rapid rise in voltage can minimize the misfires due to soot fouling.

To achieve the spark ignition performance needed for successful operation of the ignition and engine diagnostic system disclosed by Noble and, at the same time, reduce the incidence of engine misfire due to spark plug soot fouling, the spark ignition transformer's core material must have certain magnetic permeability, must not magnetically saturate during operation, and must have low magnetic losses. The combination of these required properties narrows the availability of suitable core materials. Considering the target cost of an automotive spark ignition system, possible candidates for the core material include silicon steel, ferrite, and iron-based amorphous metal. Conventional silicon steel routinely used in utility transformer cores is inexpensive, but its magnetic losses are too high. Thinner gauge silicon steel with lower magnetic losses is too costly. Ferrites are inexpensive, but their saturation inductions are normally less than 0.5 T and Curie temperatures at which the core's magnetic induction becomes close to zero are near 200.degree. C. This temperature is too low considering that the spark ignition transformer's upper operating temperature is assumed to be about 180.degree. C. Iron-based amorphous metal has low magnetic loss and high saturation induction exceeding 1.5 T, however it shows relatively high permeability. An iron-based amorphous metal capable of achieving a level of magnetic permeability suitable for a spark ignition transformer is needed.

SUMMARY OF THE INVENTION

The present invention provides a magnetic core for a coil-per-plug (CPP) spark ignition transformer which generates a rapid voltage rise and a signal that accurately portrays the voltage profile of the ignition event. The core is composed of an amorphous ferromagnetic material which exhibits low core loss and low permeability (ranging from about 100 to 300). Such magnetic properties are especially suited for rapid firing of the plug during a combustion cycle. Misfires of the engine due to soot fouling are minimized. Moreover, energy transfer from coil to plug is carried out in a highly efficient manner, with the result that very little energy remains within the core after discharge. This high efficiency energy transfer enables the core to monitor the voltage profile of the ignition event in an accurate manner. When the magnetic core material is wound into a cylinder upon which the primary and secondary wire windings are laid to form a toroidal transformer, the signal generated provides a much more accurate picture of the ignition voltage profile than that produced by cores exhibiting higher magnetic losses.

The magnetic core according to the present invention is based on an amorphous metal with a high magnetic induction, which includes iron-base alloys. Two basic forms of a core are disclosed. They are gapped and non-gapped. The gapped core has a discontinuous magnetic section in a magnetically continuous path. An example of such a core is a toroidal-shaped magnetic core having a small slit commonly known as an air-gap. The gapped configuration is adopted when the needed permeability is considerably lower than the core's own permeability as wound. The air-gap portion of the magnetic path reduces the overall permeability. The non-gapped core has a magnetic permeability similar to that of an air-gapped core, but is physically continuous, having a structure similar to that typically found in a toroidal magnetic core. The apparent presence of an air-gap uniformly distributed within the non-gapped core gives rise to the term "distributed-gap-core".

The gapped-core of the present invention has an overall magnetic permeability between about 100 and about 300 as measured at a frequency of about 1 kHz. The raw core material can have a permeability much higher than 100-300 level, but through special processing, the permeability can be reduced to the desired range without adversely affecting the other needed qualities of the iron-base amorphous alloy. An output voltage greater than 10 kV for spark ignition is achieved with less than 120 ampere-turns of primary and approximately 110 to 160 turns of secondary winding.

The non-gapped core of the present invention is made of an amorphous metal based on iron alloys and processed so that the core's magnetic permeability is between 100 and 300 as measured at a frequency of approximately 1 kHz. To improve the efficiency of non-gapped cores by reducing the eddy current losses, shorter cylinders are wound and processed and stacked end to end to obtain the desired amount of magnetic core. Leakage flux from a distributed-gap-core is much less than that from a gapped-core, emanating less undesirable radio frequency interference into the surroundings. Furthermore, because of the closed magnetic path associated with a non-gapped core, signal-to-noise ratio is larger than that of a gapped-core, making the non-gapped core especially well suited for use as a signal transformer to diagnose engine combustion processes. An output voltage at the secondary winding greater than 10 kV for spark ignition is achieved by a non-gapped core with less than 120 ampere-turns of primary and about 110 to 160 turns of secondary winding.

DRAWING DESCRIPTION:

BRIEF DESCRIPTION OF THE DRAWING

The invention will be more fully understood and further advantages will become apparent when reference is made to the following detailed description of the preferred embodiments of the invention and the accompanying drawings, in which:

FIGS. 1, 2 and 3 show a typical increase in primary current when the power is turned on and then off, the primary voltage being on the switched ground side, and the higher voltage being on the secondary side of the transformer, respectively; and

FIGS. 4a and 4b are side and top views, respectively, of the core-coil assembly of the present invention.

DETAILED DESCRIPTION:

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Magnetic cores composed of an iron-based amorphous metal having a saturation induction exceeding 1.5 T in the as-cast state were prepared. The cores had a cylindrical form with a cylinder height of about 80 mm and outside and inside diameters of about 17 and 12 mm, respectively. These cores were heat-treated with no external applied fields. Air gaps were introduced into some of the cores by cutting out some part of the cores along the cylinder axes. By keeping the total cylinder height at about 80 mm, some cores were segmented into two and five sections, each section having a subcylindrical core height of about 40 and 16 mm, respectively. Several turns and 110 to 160 turns of copper windings were applied to each of the cores as the primary and secondary coil, respectively. Plastic covering was placed over the core so that the wires were not near the core. The transformer wiring and core were then vacuum-cast in epoxy for high voltage dielectric integrity. A current was supplied in the primary coil, building up rapidly within about 25 to 100 .mu.sec to a level exceeding 100 amps.

The curve in FIG. 1 indicates the current build-up starting at about 85 .mu.sec prior to switching-off (corresponding to t=-85 .mu.sec in FIG. 1). During the current ramp-up, the voltage across the primary winding is close to zero as shown in FIG. 2. At t=0, the primary current is cut off, which results in a large magnetic flux change, generating a large voltage in the secondary coil. The voltage profiles in the primary and secondary coils are represented by the curves in FIGS. 2 and 3, respectively. These voltage profiles are readily displayed using an oscilloscope of the conventional type. It is noted that the high voltage in the secondary coil is generated within a short period of time, typically less than 5 .mu.sec. Thus, in the magnetic cores of the present invention, a high voltage, exceeding 10 kV, can be repeatedly generated at time intervals of less than 100 .mu.sec. This feature is required to achieve the rapid multiple sparking action mentioned above. Moreover, the rapid voltage rise produced in the secondary winding reduces engine misfires resulting from soot fouling.

In addition to the advantages relating to spark ignition event described above,

LITIGATION SEARCH FOR LINDA SHOLL: US 5,868,123 (reissue 09/779,877)

Files searched in QUESTEL ORBIT:

Databases : LGST, CRXX, PAST, LITA

?us5868123/pn

Term not in index/PN-CRXX : US5868123
Term not in index/PN-PAST : US5868123
Term not in index/PN-LITA : US5868123

LGST	1
CRXX	0
PAST	0
LITA	0

1/1 LGST (1/1) - (C) LEGSTAT
PN - US 5868123 [US5868123]
AP - US 672909/96 19960628 [1996US-0672909]
DT - US-P
ACT - 19960628 US/AE-A
APPLICATION DATA (PATENT)
{US 672909/96 19960628 [1996US-0672909]}
- 19960628 US/AS02
ASSIGNMENT OF ASSIGNOR'S INTEREST
ERNEST D. BUFF P.O. BOX 2245 101 COLUMBIA ROAD MORRISTOWN, NEW JERSEY 07962 * HASEGAWA, RYUSUKE : 19960626; SILGAILIS, JOHN : 19960626; GRIMES, DONALD ALLEN : 19960626
- 19990209 US/A
PATENT
UP - 2000-04

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Files searched in LEXIS and NEXIS:
All patent files

PATNO IS 5868123

Your search request has found 1 PATENT through Level 1.

LEVEL 1 - 1 OF 1 PATENT

<5,868,123>

<<=2>> GET 1st DRAWING SHEET OF 4

Feb. 9, 1999

Magnetic core-coil assembly for spark ignition systems

CORE TERMS: ignition, magnetic, spark, secondary, engine, voltage, transformer, coil, core-coil, magnetic core...
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File searched: CASES

Your search request has found no CASES.

File searched: JOURNALS

Your search request has found no ITEMS.

File searched: NEWS STORIES

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File searched in DIALOG:

File 345:Inpadoc/Fam.& Legal Stat 1968-2001/UD=200130
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S1 1 PN="US 5868123"

1/39/1
DIALOG(R)File 345:Inpadoc/Fam.& Legal Stat
(c) 2001 EPO. All rts. reserv.

13621968
Basic Patent (No,Kind,Date): WO 9713259 A1 19970410 <No. of Patents: 007>
Patent Family:

Patent No	Kind	Date	Applic No	Kind	Date	
AU 9672567	A1	19970428	AU 9672567	A	19961004	
BR 9611004	A	19990713	BR 96U11004	A	19961004	
CN 1202976	A	19981223	CN 96198511	A	19961004	
EP 853809	A1	19980722	EP 96934054	A	19961004	
JP 10512401	T2	19981124	JP 96514468	A	19961004	
US 5868123	A	19990209	US 672909	A	19960628	
WO 9713259	A1	19970410	WO 96US15952	A	19961004	(BASIC)

Priority Data (No,Kind,Date):
US 4815 P 19951005
US 672909 A 19960628
WO 96US15952 W 19961004
US 604815 A 19951005

PATENT FAMILY:
AUSTRALIA (AU)
Patent (No,Kind,Date): AU 9672567 A1 19970428
MAGNETIC CORE-COIL ASSEMBLY FOR SPARK IGNITION SYSTEMS (English)
Patent Assignee: ALLIED SIGNAL INC
Author (Inventor): HASEGAWA RYUSUKE; SILGAILIS JOHN; GRIMES DONALD
Priority (No,Kind,Date): US 4815 P 19951005; US 672909 A 19960628; WO 96US15952 W 19961004
Applic (No,Kind,Date): AU 9672567 A 19961004
IPC: * H01F-001/153
Derwent WPI Acc No: * C 97-226440
Language of Document: English

BRAZIL (BR)
Patent (No,Kind,Date): BR 9611004 A 19990713
CONJUNTO DE BOBINA-NUCLEO MAGNETICO PARA SISTEMAS DE IGNICAO A CENTELHAS (Portugese)

Patent Assignee: ALLIED SIGNAL INC (US)
Author (Inventor): HASEGAWA RYUSUKE; SILGAILIS JOHN; GRIMES DONALD
Priority (No,Kind,Date): US 4815 P 19951005; US 672909 A 19960628; WO 96US15952 W 19961004
Applic (No,Kind,Date): BR 96U11004 A 19961004
IPC: * H01F-001/153
Derwent WPI Acc No: * C 97-226440
Language of Document: Portugese

CHINA (CN)
Patent (No,Kind,Date): CN 1202976 A 19981223
MAGNETIC CORE-COIL ASSEMBLY FOR SPARK IGNITION SYSTEMS (English)
Patent Assignee: ALLIED SIGNAL INC (US)
Author (Inventor): HASEGAWA R (US); SILGALLIS J (US); GRIMES D (US)
Priority (No,Kind,Date): US 4815 P 19951005; US 672909 A 19960628
Applic (No,Kind,Date): CN 96198511 A 19961004
IPC: * H01F-001/153
Derwent WPI Acc No: * C 97-226440
Language of Document: Chinese

EUROPEAN PATENT OFFICE (EP)
Patent (No,Kind,Date): EP 853809 A1 19980722
MAGNETIC CORE-COIL ASSEMBLY FOR SPARK IGNITION SYSTEMS (English; French ; German)
Patent Assignee: ALLIED SIGNAL INC (US)
Author (Inventor): HASEGAWA RYUSUKE (US); SILGAILIS JOHN (US); GRIMES DONALD (US)
Priority (No,Kind,Date): WO 96US15952 W 19961004; US 604815 A 19951005; US 672909 A 19960628
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IPC: * H01F-001/153
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Language of Document: English

EUROPEAN PATENT OFFICE (EP)
Legal Status (No,Type,Date,Code,Text):

EP 853809	P	19951005	EP AA	PRIORITY (PATENT APPLICATION) (PRIORITAET (PATENTANMELDUNG)) US 604815 A 19951005
EP 853809	P	19960628	EP AA	PRIORITY (PATENT APPLICATION) (PRIORITAET (PATENTANMELDUNG)) US 672909 A 19960628
EP 853809	P	19961004	EP AA	PCT-APPLICATION (PCT-ANMELDUNG) WO 96US15952 W 19961004
EP 853809	P	19961004	EP AE	EP-APPLICATION (EUROPAEISCHE ANMELDUNG) EP 96934054 A 19961004
EP 853809	P	19980722	EP AK	DESIGNATED CONTRACTING STATES IN AN APPLICATION WITH SEARCH REPORT: (IN EINER ANMELDUNG BENANNTE VERTRAGSSTAATEN) AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC

NL PT SE

EP 853809 P 19980722 EP A1 PUBLICATION OF APPLICATION WITH SEARCH REPORT (VEROEFFENTLICHUNG DER ANMELDUNG MIT RECHERCHENBERICHT)

EP 853809 P 19980722 EP 17P REQUEST FOR EXAMINATION FILED (PRUEFUNGSANTRAG GESTELLT) 980402

EP 853809 P 20000126 EP 17Q FIRST EXAMINATION REPORT (ERSTER PRUEFUNGSBESCHEID) 19991208

EP 853809 P 20000628 EP RAP1 APPLICANT REASSIGNMENT (CORRECTION) (ANMELDER UEBERTRAGUNG (KORR.))

HONEYWELL INTERNATIONAL INC.

JAPAN (JP)
Patent (No,Kind,Date): JP 10512401 T2 19981124
Priority (No,Kind,Date): WO 96US15952 W 19961004; US 4815 P 19951005; US 672909 A 19960628
Applic (No,Kind,Date): JP 96514468 A 19961004
IPC: * H01F-038/12; H01F-001/153
Derwent WPI Acc No: * C 97-226440
Language of Document: Japanese

UNITED STATES OF AMERICA (US)
Patent (No,Kind,Date): US 5868123 A 19990209
MAGNETIC CORE-COIL ASSEMBLY FOR SPARK IGNITION SYSTEMS (English)
Patent Assignee: ALLIED SIGNAL INC (US)
Author (Inventor): HASEGAWA RYUSUKE (US); SILGAILIS JOHN (US); GRIMES DONALD (US)
Priority (No,Kind,Date): US 672909 A 19960628; US 4815 P 19951005
Applic (No,Kind,Date): US 672909 A 19960628
National Class: * 123634000
IPC: * F02D-003/02
Derwent WPI Acc No: * C 97-226440
Language of Document: English

UNITED STATES OF AMERICA (US)
Legal Status (No,Type,Date,Code,Text):

US 5868123 P 19951005 US AA PRIORITY US 4815 P 19951005

US 5868123 P 19960628 US AE APPLICATION DATA (PATENT) (APPL. DATA (PATENT)) US 672909 A 19960628

US 5868123 P 19960628 US AS02 ASSIGNMENT OF ASSIGNOR'S INTEREST ERNEST D. BUFF P.O. BOX 2245 101 COLUMBIA ROAD MORRISTOWN, NEW JERSEY 07962 ; HASEGAWA, RYUSUKE : 19960626; SILGAILIS, JOHN : 19960626; GRIMES, DONALD ALLEN : 19960626

US 5868123 P 19990209 US A PATENT

WORLD INTELLECTUAL PROPERTY ORGANIZATION, PCT (WO)
Patent (No,Kind,Date): WO 9713259 A1 19970410
MAGNETIC CORE-COIL ASSEMBLY FOR SPARK IGNITION SYSTEMS (English)
Patent Assignee: ALLIED SIGNAL INC (US)

Author (Inventor): HASEGAWA RYUSUKE; SILGAILIS JOHN; GRIMES DONALD
Priority (No,Kind,Date): US 4815 P 19951005; US 672909 A 19960628
Applic (No,Kind,Date): WO 96US15952 A 19961004
Designated States: (National) AU; BR; CN; JP; KR; MX; RU (Regional) AT; BE; CH; DE; DK; ES; FI; FR; GB; GR; IE; IT; LU; MC; NL; PT; SE
Filing Details: WO 100000 With international search report
IPC: * H01F-001/153
Derwent WPI Acc No: ; C 97-226440
Language of Document: English

WORLD INTELLECTUAL PROPERTY ORGANIZATION, PCT (WO)
Legal Status (No,Type,Date,Code,Text):

WO 9713259	P	19951005	WO AA	PRIORITY CLAIMED US 4815 P 19951005
WO 9713259	P	19960628	WO AA	PRIORITY (PATENT) US 672909 A 19960628
WO 9713259	P	19961004	WO AE	APPLICATION DATA (APPL. DATA) WO 96US15952 A 19961004
WO 9713259	P	19970410	WO AK	DESIGNATED STATES CITED IN A PUBLISHED APPLICATION WITH SEARCH REPORT (DESIGNATED STATES CITED IN A PUBLISHED APPL. WITH SEARCH REPORT) AU BR CN JP KR MX RU
WO 9713259	P	19970410	WO AL	DESIGNATED COUNTRIES FOR REGIONAL PATENTS CITED IN A PUBLISHED APPLICATION WITH SEARCH REPORT (DESIGNATED COUNTRIES FOR REGIONAL PATENTS CITED IN A PUBLISHED APPL. WITH SEARCH REPORT) AT BE CH DE DK ES FI FR GB GR IE IT LU MC NL PT SE
WO 9713259	P	19970410	WO A1	PUBLICATION OF THE INTERNATIONAL APPLICATION WITH THE INTERNATIONAL SEARCH REPORT (PUB. OF THE INTERNATIONAL APPL. WITH THE INTERNATIONAL SEARCH REPORT)
WO 9713259	P	19970515	WO DFPE	REQUEST FOR PRELIMINARY EXAMINATION FILED PRIOR TO EXPIRATION OF 19TH MONTH FROM PRIORITY DATE
WO 9713259	P	19970730	WO 121	EP: PCT APP. ART. 158 (1) (EP: PCT ANM. ART. 158 (1))

END LITIGATION SEARCH US 5868123

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